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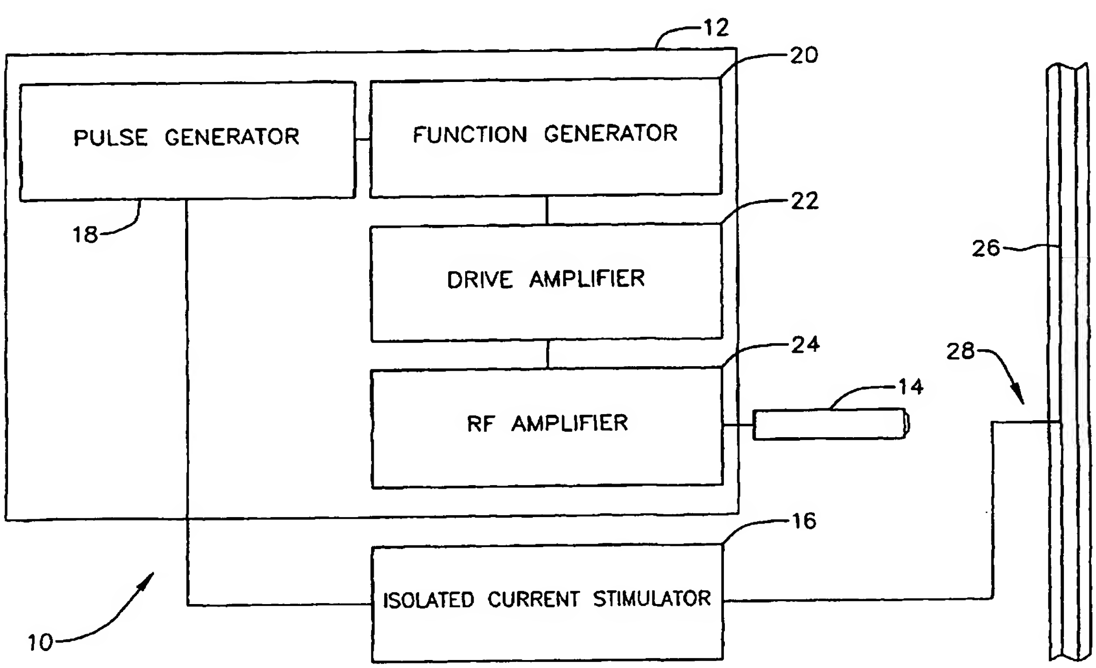
(54) Title: NEUROSTIMULATOR



(57) Abstract: Methods and devices of stimulating nerves are disclosed. In one embodiment adapted for stimulating excitable tissue, the invention includes drive circuitry (12), an acoustic transducer (14) and a pair of electrodes (28).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

AMENDED CLAIMS

[Received by the International Bureau on 05 April 2004 (05.04.03): original claims 1, 11, 14, 17 and 20 replaced by amended claims 1, 11, 14, 17 and 19. Original claims 2-10, 12-13, 15-16, 21 and 23 unchanged. Original claims 18 and 22 cancelled. (4 pages)]

1. A neurostimulator for stimulating excitable tissue, comprising:
drive circuitry;
an acoustic transducer connected to the drive circuitry;
a pair of electrodes driven by the drive circuitry; and
wherein the drive circuitry is configured to generate action potential in neurons via the acoustic transducer and the electrodes.

2. The neurostimulator of claim 1, wherein:
the drive circuitry is configured to drive the acoustic transducer to generate a pressure wave;
the acoustic transducer is positioned to direct the pressure wave at the excitable tissue; and
the drive circuitry is configured to generate stimulating current between the pair of electrodes.

3. The neurostimulator of claim 1, wherein:
the pair of electrodes are implemented using a piezoelectric chip;
the drive circuitry is configured to drive the acoustic transducer to generate a pressure wave; and
the acoustic transducer is positioned to direct the pressure wave towards the piezoelectric chip.

4. The neurostimulator of claim 3, wherein the piezoelectric chip comprises:
a piezoelectric element having at least two opposite surfaces;
a diode;
a biocompatible coating surrounding the piezoelectric element and the diode; and
an electrode located adjacent each of the opposite surfaces, where each electrode is partially contained by the biocompatible coating.

5. The neurostimulator of claim 4, wherein the piezoelectric element includes zirconate titanate (PZT).

6. The neurostimulator of claim 4, where in the piezoelectric element includes polyvinylidene fluoride (PVDF).

7. The neurostimulator of claim 3, further comprising additional piezoelectric chips.

8. The neurostimulator of claim 7, wherein:
each of the piezoelectric chips has a different resonant frequency; and
the drive circuitry is configured to drive the acoustic transducer at the resonant frequency of one of the piezoelectric chips.

9. The neurostimulator of claim 1, wherein the drive circuitry further comprises:
a pulse generator;
a function generator connected to the pulse generator; and
amplifier circuitry connected to the function generator.

10. The neurostimulator of claim 9, wherein the amplifier circuitry comprises:
a drive amplifier; and
a RF amplifier.

11. A transcutaneous neural stimulator, comprising:
drive circuitry;
an acoustic transducer;
a pair of electrodes; and
wherein the drive circuitry is configured to generate action potential in neurons via the acoustic transducer and the electrodes.

12. The neural stimulator of claim 11, wherein:
the drive circuitry is configured to drive the acoustic transducer to generate a pressure wave;
the acoustic transducer is positioned to direct the pressure wave at the excitable tissue; and
the drive circuitry is configured to generate stimulating current between the pair of electrodes.

13. The neural stimulator of claim 11, wherein:
the pair of electrodes are implemented using a piezoelectric chip;
the drive circuitry is configured to drive the acoustic transducer to generate a pressure wave; and
the acoustic transducer is positioned to direct the pressure wave towards the piezoelectric chip.

14. A device for stimulating the pudental nerve, comprising:
drive circuitry;
an acoustic transducer connected to the drive circuitry;
a pair of electrodes driven by the drive circuitry; and
wherein the drive circuitry is configured to generate action potential in neurons via the acoustic transducer and the electrodes.

15. The device of claim 14, wherein:
the drive circuitry is configured to drive the acoustic transducer to generate a pressure wave;
the acoustic transducer is positioned to direct the pressure wave at the pudental nerve; and
the drive circuitry is configured to generate stimulating current between the pair of electrodes.

16. The device of claim 14, wherein:
the pair of electrodes is implemented using a piezoelectric chip;
the drive circuitry is configured to drive the acoustic transducer to generate a pressure wave; and
the acoustic transducer is positioned to direct the pressure wave towards the piezoelectric chip.

17. A neurostimulator, comprising:
pressure wave generation means;
electrode means; and
wherein the pressure wave generation means and the electrode means provide action potential in neurons.

18. A method of stimulating excitable tissue, comprising directing pressure waves at a piezoelectric chip located proximate the excitable tissue.

19. A method of preventing transmission of pain signals, comprising stimulating neurons using ultrasound and electric currents.

20. A method of preventing transmission of pain, comprising directing pressure waves at a piezoelectric chip located proximate a nerve.

21. A method of stimulating the pudental nerve, comprising directing pressure waves at a piezoelectric chip located proximate the pudental nerve.